M2 internship at Telecom Paris
New deep learning approaches for speckle reduction and water segmentation with SWOT satellite images

Place and dates: Télécom Paris, 19 pace Marguerite Perey, Palaiseau; beginning: March or April

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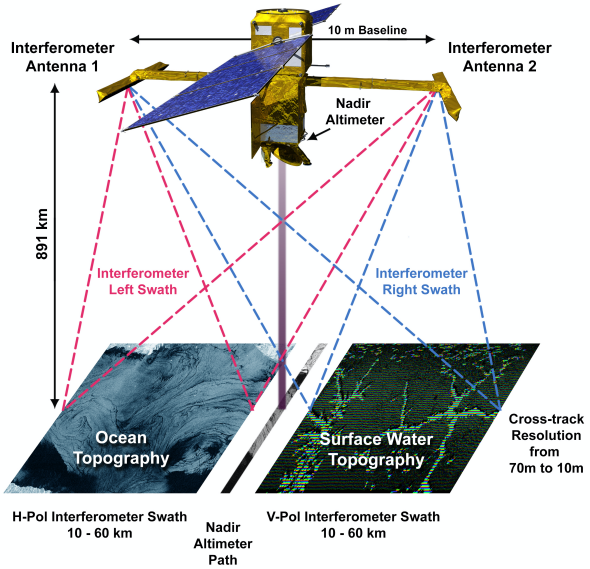
Context

In 2023 a new SAR (Synthetic Aperture Radar) sensor has been launched in the framework of the SWOT (Surface Water and Ocean Topography) mission led by NASA and CNES. The aim of this mission is to measure the elevation of water by observing major lakes, rivers and wetlands, and detecting ocean features. To do so, the sensor of the mission is the KaRIn instrument with two antennas separated by 10 meters providing simultaneously two SAR images (see figure below). This instrument is able to provide interferometric data which give access to the elevation of the points on the Earth surface.

The algorithms to process these data have been developped using simulated data before the launch of the satellite. Since a few months, real images produced by SWOT are available, making it possible to design more refined approaches using machine learning techniques.



The two modes of the SWOT mission, one for the ocean observation with a coarse resolution, and the other one with a finer resolution for continental applications.

Objective of the internship
The images acquired by the SAR interferometer on SWOT are very noisy because of the speckle phenomenon. Recent advances of deep learning methods in denoising should help to largely improve these images and reduce their fluctuations both for the amplitude data (power of the backscattered field) or the interferometric data with phase and coherence information. The aim of the internship is to develop new approaches adapted to the specificities of the SWOT images.

The work will rely on previous works of the team developed for other SAR sensors [1, 2]. They are based on the use of self-supervised learning strategies and exploit data diversity (independence of the real and imaginary part of complex images, multi-temporal acquisitions, etc.). All these methods are based on some assumptions on the data acquisition that should be verified by the sensor or enforced by an adequate pre-processing step. The analysis of the properties and specificities of the new SWOT data will lead to the adaptation of self-supervised despeckling methods to SWOT images.

In a second phase, segmentation methods based on weakly supervised learning and the exploitation of the representation space learned by the despeckling approaches will be considered, as in [3].

Practical information
The internship will be done in the IMAGES team (Image, Modeling, Analysis, Geometry and Synthesis) of the IDS (Image, Données, Signal) department of Télécom Paris, laboratory LTCI.

The project will be led in collaboration with CNES (Nicolas Gasnier) and offer the opportunity to do a PhD on an extended subject.

Requirements
Master 2 level or last year of engineer school with the following specialities: computer science or applied maths with specialization in image processing and data science.

Application
To apply to this position, please send a CV and recent transcripts (M1 level and on-going semester if possible).

References

[1] E. Dalsasso, L. Denis, and F. Tupin, "SAR2SAR: a self-supervised despeckling algorithm for SAR images," *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, 2021.

[2] ——, "As if by magic: self-supervised training of deep despeckling networks with MERLIN," *IEEE Transactions on Geoscience and Remote Sensing*, 2022.

[3] E. Dalsasso, C. Rambour, N. Trouvé, and N. Thome, "MERLIN-Seg: self-supervised despeckling for label-efficient semantic segmentation," Jul. 2023, working paper or preprint. [Online]. Available: https://cnam.hal.science/hal-04163624